This sequence too can again be generated by a transmultiplexer, whereas the following is valid:

$$h_k(n) = \frac{1}{\sqrt{M}} e^{j\frac{2\pi}{M}(n-P)} , \quad n = 0, 1, \ldots, N + P - 1 , \tag{35}$$

Fig. 16, 17 shows some transmission functions for a system with $M = 16$ and $P = 5$. It is evident that here, overlap of the side lobes occurs which is not very nice. For this reason, the compensation method cannot be used here.

For this reason, no cyclical prefix is employed in transmission but a Guard Interval of the length P.

The compensation pulse computed in the previous section complies with this condition. If however the compensation pulse is to be longer than M taps, M coefficients must always be followed by P zeros. This construction effects that the transmission sequence contains a Guard Interval of the length P after M values.

$$g = [g_0^T 0_P g_1^T 0_P \ldots g_{R-1}^T]^T \tag{36}$$

The vectors g_k each contain M coefficients. The following P zeros are included in the line vector 0_P. In order for the demodulation and separation of the data in the receiver to be capable of being carried out through a DFT, all the vectors g_k must lie in the subspace L. The following optimization problem may be written down for the compensation pulse:

$$g(n) = \arg \min_{\substack{g_0(n)\in\mathcal{L} \\ g_1(n)\in\mathcal{L} \\ \vdots \\ g_{R-1}(n)\in\mathcal{L}}} W_1 \int_{k\frac{2\pi}{M}}^{(k+1)\frac{2\pi}{M}} |G(e^{j\theta}) - S(e^{j\theta})|^2 \, d\theta + \sum_{l=2}^{Q} W_l \int_{\theta_{l_1}}^{\theta_{l_2}} |G(e^{j\theta})|^2 \, d\theta \tag{37}$$

On account of the secondary factor $g_k \in L$

$$g_k = \boldsymbol{H} c_k \tag{38}$$

may be stated again. The matrix $\boldsymbol{H}$ is defined in (20). Taking (36) and (38) into consideration, the frequency response of the compensation pulse becomes

$$G(e^{j\theta}) = \sum_{n=0}^{(R-2)(M+L)+M} g(n)e^{-j\theta n} = \sum_{k=0}^{R-1} g_k^T \psi_k(e^{j\theta}) = \sum_{k=0}^{R-1} c_k^T H^T \psi_k(e^{j\theta}) \,. \tag{39}$$

Fig. 18: diagrammatic illustration of *g(n)* when the length is greater than *M*.

The newly introduced value $\psi_k(e^{j\theta})$ reads

$$\psi_k(e^{j\theta}) = [e^{-jk(M+L)\theta} \; e^{-j(k(M+L)+1)\theta} \; \ldots \; e^{-j(k(M+L)+M-1)\theta}]^T \,. \tag{40}$$

If in (37) one substitutes and multiplies out, the following minimization problem occurs:

$$\begin{pmatrix} c_0 \\ c_1 \\ \vdots \\ c_{R-1} \end{pmatrix} = \arg \min_{\substack{c_0 \\ c_1 \\ \vdots \\ c_{R-1}}} \sum_{l=1}^{Q} W_l \sum_{k=0}^{R-1} \sum_{\kappa=0}^{R-1} c_k^t H^t \Theta_{k,\kappa}(\theta_{l_1}, \theta_{l_2}) H c_\kappa - \tag{41}$$

$$W_1 \left(\sum_{m=0}^{R-1} \left(s^t \Theta_{0,m}(\theta_{l_1}, \theta_{l_2}) H c_m + c_m^t H^t \Theta_{m,0}(\theta_{l_1}, \theta_{l_2}) s \right) - s^t \Theta_{0,0}(\theta_{l_1}, \theta_{l_2}) s \right) \tag{42}$$

The matrix $\Theta_{k,K}(\theta_{l1}, \theta_{l2})$ is

$$\Theta_{k,\kappa}(\theta_{l_1}, \theta_{l_2}) = \int_{\theta_{l_1}}^{\theta_{l_2}} \psi_k^*(e^{j\theta}) \psi_\kappa^T(e^{j\theta}) \, d\theta \, . \tag{43}$$